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James City County Shoreline Management Plan

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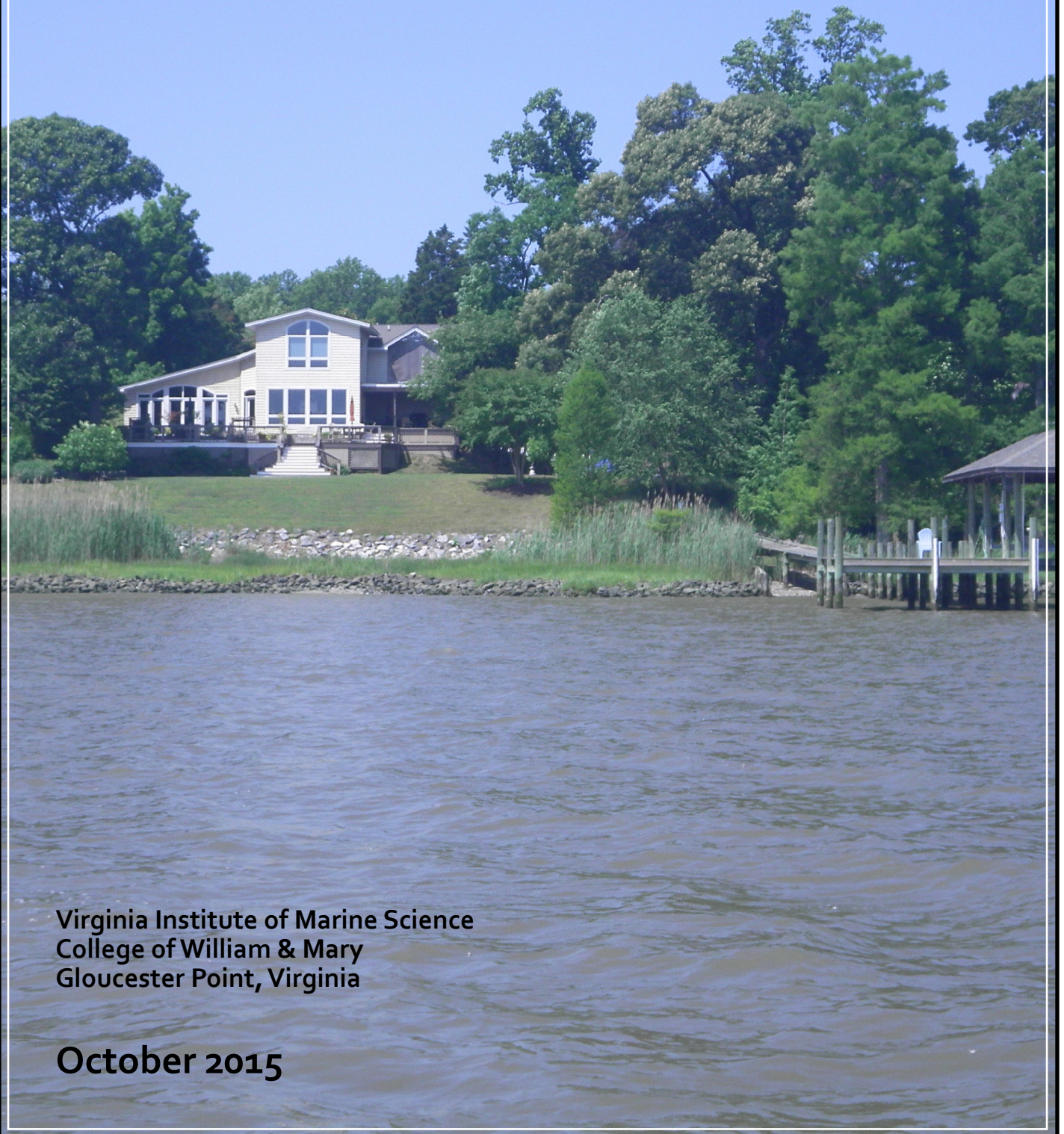
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James City County Shoreline Management Plan



Virginia Institute of Marine Science
College of William & Mary
Gloucester Point, Virginia

October 2015

James City County Shoreline Management Plan

*Prepared for
James City County and
Virginia Coastal Zone Management Program*

Shoreline Studies Program

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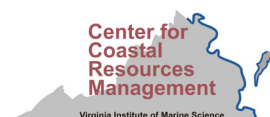
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1 Introduction

With approximately 85 percent of the Chesapeake Bay shoreline privately owned, a critical need exists to increase awareness of erosion potential and the choices available for shore stabilization that maintains ecosystem services at the land-water interface. The National Academy of Science published a report that spotlights the need to develop a shoreline management framework (NRC, 2007). It suggests that improving awareness of the choices available for erosion control, considering cumulative consequences of erosion mitigation approaches, and improving shoreline management planning are key elements to minimizing adverse environmental impacts associated with mitigating shore erosion.

Actions taken by waterfront property owners to stabilize the shoreline can affect the health of the Bay as well as adjacent properties for decades. With these long-term implications, managers at the local level should have a more proactive role in how shorelines are managed. James City County recognizes that its natural environment is one of its most valuable assets as well as its most vulnerable (James City County, 2015). The shores of James City range from exposed open river to very sheltered creeks, and the nature of shoreline change varies accordingly (Figure 1-1). This shoreline management plan is useful for evaluating and planning shoreline management strategies appropriate for all the creeks and rivers of James City. It ties the physical and hydrodynamic elements of tidal shorelines to the various shoreline protection strategies.

Much of the James City County's shoreline is suitable for a "Living Shoreline" approach to shoreline management. The Commonwealth of Virginia has adopted policy stating that Living Shorelines are the preferred alternative for erosion control along tidal waters in Virginia (<http://leg1.state.va.us/cgi-bin/legp504.exe?111+ful+CHAPo885+pdf>). The policy defines a Living Shoreline as ... "a shoreline management practice that provides erosion control and water quality benefits; protects, restores or enhances natural shoreline habitat; and maintains coastal processes through the strategic placement of plants, stone,

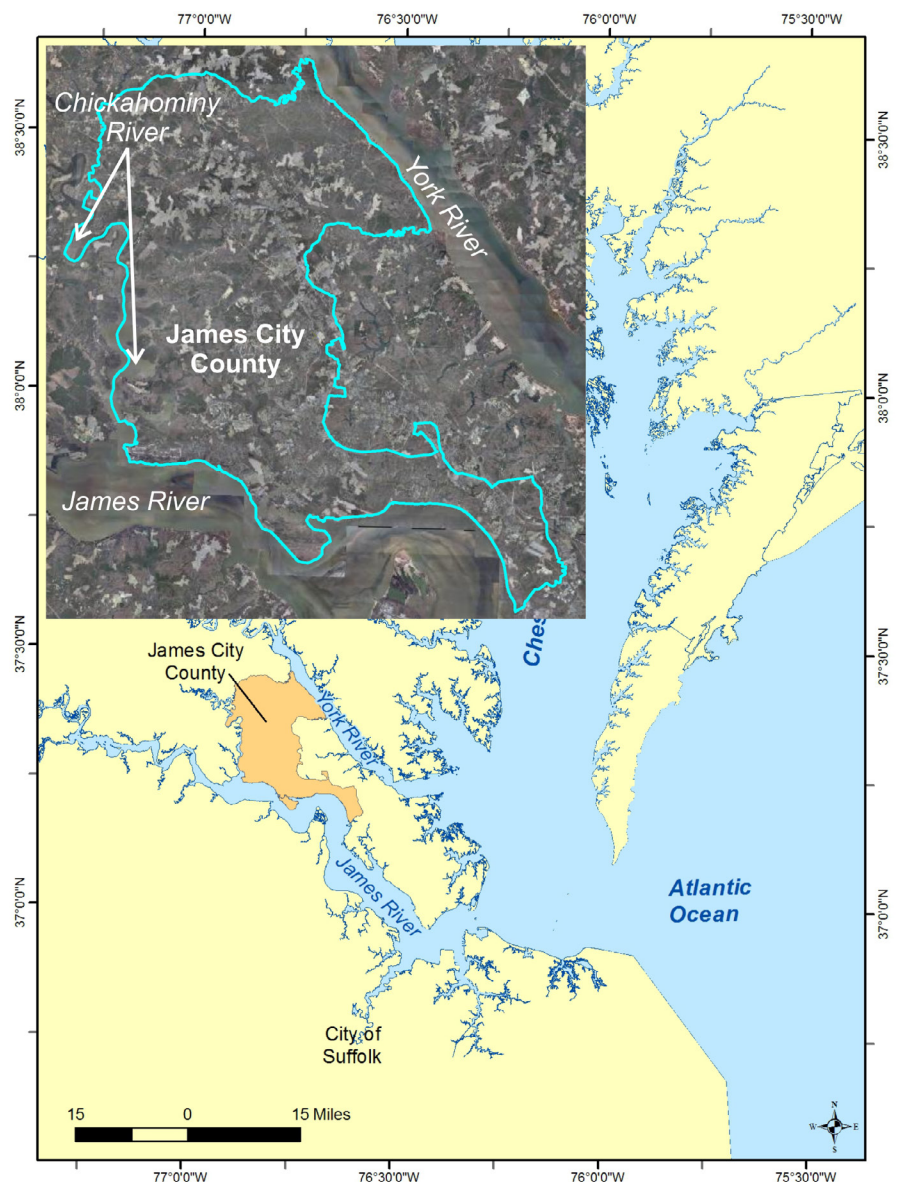


Figure 1-1. Location of James City County within the Chesapeake Bay estuarine system.

sand fill, and other structural and organic materials.” The key to effective implementation of this policy at the local level is understanding what constitutes a Living Shoreline practice and where those practices are appropriate. This management plan and its use in zoning, planning, and permitting will provide the guidance necessary for landowners and local planners to understand the alternatives for erosion control and to make informed shoreline management decisions.

The recommended shoreline strategies can provide effective shore protection but also have the added distinction of creating, preserving, and enhancing wetland, beach, and dune habitat. These habitats are essential to addressing the protection and restoration of water quality and natural resources within the Chesapeake Bay watershed. The final James City County Shoreline Management Plan is an educational and management reference for the City and its landholders.

2 Coastal Setting

2.1 Geology/Geomorphology

2.1.1 Geology

James City County lies in the coastal plain of Virginia. Like many coastal localities, the County boundaries are defined by creeks, rivers and watershed. It is generally bounded along its northeast side by the York River, the James River along the southern boundary, and the Chickahominy River along the west. James City County (2015) reports 152 miles of shoreline along these three rivers, containing 138 miles of marshlands and 14 miles of beach. The York River has about 17 miles of shoreline in James City County.

The James and Chickahominy Rivers have watersheds with broad flood plains that have been occupied for 100,000s years as sea level has risen and fallen across the Virginia Coastal Plain during the Pleistocene. These include from youngest to oldest: modern alluvium (al); upper Pleistocene Tabb Formation, Sedgefield Member (Qts); Middle Pleistocene, Shirley Formation (Qsh), and the Yorktown Formation (Tc) as well as others. The York River shoreline consists of eroding banks of the Shirley Formation (Qsh) and the Windsor Formation (Qtw) and upper Pliocene Bacon's Castle Formation (Tb2) (Figure 2-1).

These riverine and estuarine sediments have been deposited in successive high stands which lie unconformably on each other and which overlie older Pliocene formations. The surficial geology of the shoreline banks include strata from Lower Pleistocene to Upper Pleistocene strata with Holocene marshes occupying secondary tidal creeks. Typically, the older strata are at higher elevations which decrease through time with each successive marine transgression. Therefore, the sediments differ in each strathigraphic unit and provide different amounts of gravel, sand, silt, and clay to the littoral system through shoreline erosion.

The coastal morphology, topography, and hydrology of James City County are seen in Figures 2-2, 2-3, and 2-4. Along the James River, the Chickahominy River marks the transition zone between the sharp meandering tidal channels of the upriver James River and the wider estuarine section of the watershed. There is a similar but smaller scale transition up the Chickahominy River at about Simpson Island (Figure 2-2). Here, as on the James River, the erosion processes go from tide dominated in the upriver section to

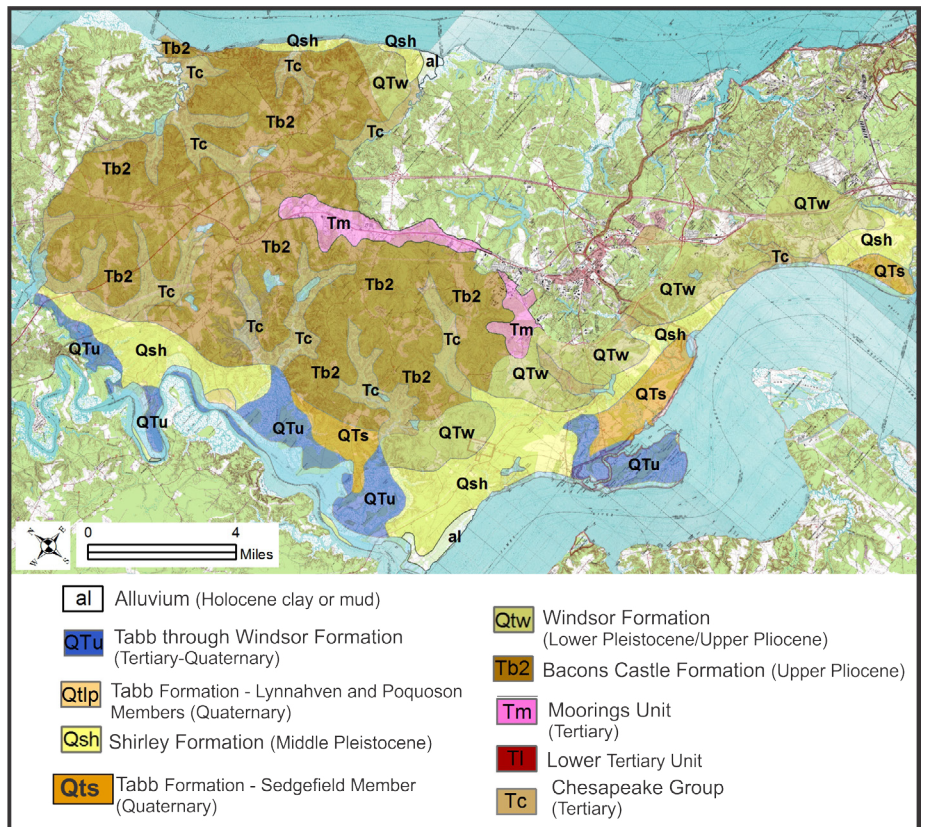


Figure 2-1. Geology of James City County (Mixon et al., 1989).

wind/wave driven in the downriver section. The open York River coast is wave dominated.

The Chickahominy River is a series of meandering bends with fresh water marshes and swamp forest shorelines with deep narrow channels (Figure 2-2). It is less than half a mile wide at the upper boundary with Charles City County and New Kent County and widens to nearly one mile wide by Simpson Island and 1.6 miles wide at the Barret's Point the river mouth. At the juncture with the James River the fetch is over two miles to the south across the James. The James River shoreline extends down the James River to Skiffes Creek (Figure 2-3), the downriver boundary with the City of Newport News. The James River shore exhibits some riverine morphology with Jamestown Island and Hog Point (in Surry county) being ancient point bars of the ancestral James River.

The federally-maintained navigation channel of the James River is about 1.8 miles off Barrets Point. The bathymetry becomes shallower toward the James City County shoreline and the six foot contour lies about 1000 feet offshore at Barrets Point. The 6 ft contour can be used to assess the potential wave attenuation across the nearshore of a given shoreline (Hardaway and Byrne, 1999). The further offshore the better the potential wave attenuation.

The six foot contour widens to 2000 feet offshore downriver before coming closer to shore, within about 500 feet, at the Jamestown Ferry (Figure 2-3). The 6 foot contour draws very close to Jamestown Island, within about 200 feet, at the original settlement site which

is one reason Jamestown Island was selected for settlement in the 1600s. The six foot contour remains about 200 off shore at Lower Point on Jamestown Island. The distance to the six foot contour widens to about 1,500 feet at College Creek and narrows along Kingsmill and Carters Grove Plantation to less the 400 feet offshore. The nearshore shelf widens again at Skiffes Creek to about 4,000 feet.

The different orientations of the James River shoreline cause varying fetch directions and distances. The James River channel thalweg coincides with the shipping channel, and ship wakes add to the hydrodynamic

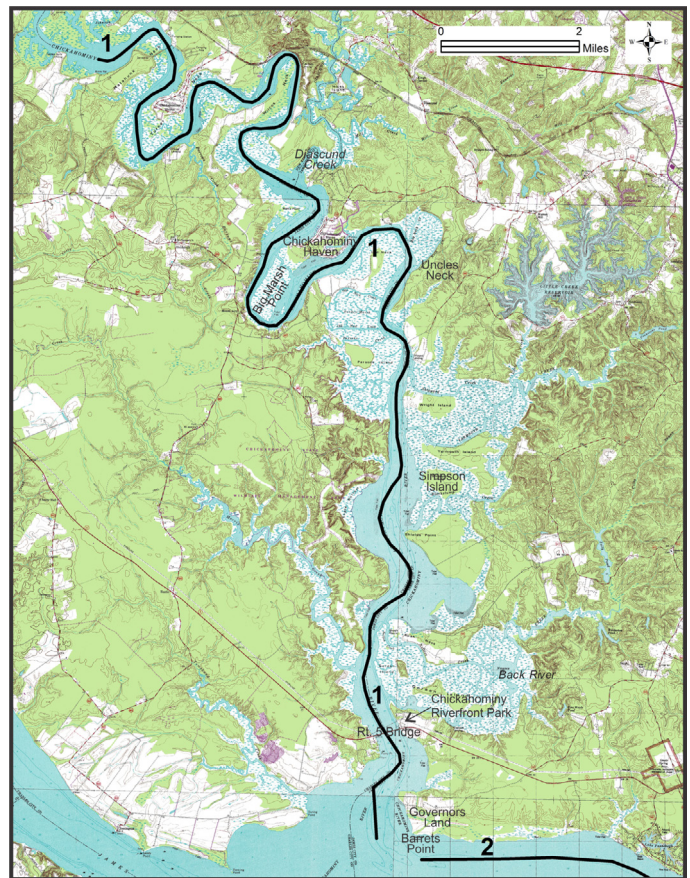


Figure 2-2. Topographic sheet of the Chickahominy River James City County. Also shown are the reach designations.



Figure 2-3. Topographic sheet of the James River section of James City County. Also shown are the reach designations.

processes. Maintenance dredging has been required for a long time and often the dredged material is placed onto adjacent shoals thereby altering tidal flow and wind driven wave generation across certain fetch exposures. The

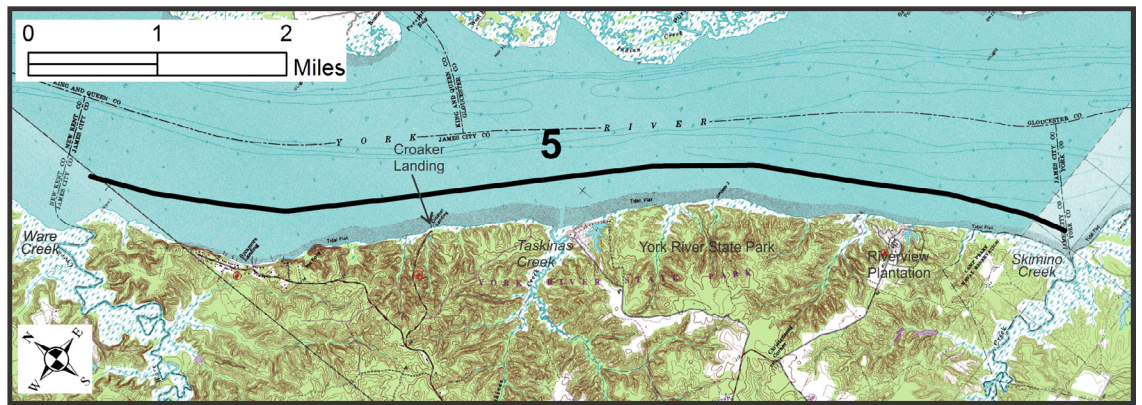


Figure 2-4. Topographic sheet of the York River section of James City County. Also shown are the reach designations.

James River and York River channels are relicts of the deep downcutting in the older coastal plain strata that occurred when sea level was much lower. Numerous oceanic transgressions and regression have occurred since, modifying the flood plain sedimentation each time. The last low stand was about 15,000 before present when the ocean coast was about 60 miles east and sea level was about 300 feet lower.

The York River shoreline of James City County extends from Skimino Creek at the downriver boundary with York County to Ware Creek at the upriver boundary with New Kent County (Figure 2-4), a distance of just over 7 miles. The 6 foot contour runs about 1,500 to 2,000 feet along most of the York River shoreline, but widens to over 4,000 feet off Ware Creek. The York River is relatively narrow, only about 1 to 1.5 miles wide with fetch exposures of 8 miles to the north and 12 miles to the southeast.

2.1.2 Shoreline Morphology

Today coastal morphology/landscape is a function of the underlying geologic history. All of James City's James River shoreline is tidal while two-thirds of the Chickahominy is tidal. The County's shoreline can be divided into five reaches for ease of discussion (Figures 2-2, 2-3 and 2-4). These reaches are defined based on shore morphology and drainage patterns. One reach exists along the Chickahominy (Reach 1), three reaches along the James River (Reaches 2-4) coast and one reach along the York River coast (Reach 5).

Reach 1 begins in the Chickahominy River at the New Kent County line at the confluence of Diascund Creek. The shoreline occurs along the outside meander of the Chickahominy and can be classified as swamp forest. The shoreline generally has a very low erosion rate, less than one foot per year (Milligan *et al.*, 2010). Other areas have low erosion, but near Simpson Island the shoreline is eroding at two to three feet per year. Farther south toward the James River, shore change varies between very low erosion to medium erosion.

The 1.5 miles south of the New Kent County line of Reach 1 are developed with many single homes, cottages, and numerous piers and docks (Figure 2-5). One development, Chickahominy Haven, spans the whole neck and includes several hundred feet of canal shoreline that was likely created in the 1960s. Much of the shoreline has been hardened with various types of bulkheads. The meandering coast becomes a fresh water marsh around Big Marsh Point which has become an island due to a channel cut just south of Chickahominy Haven.

Uncles Neck is a development consisting of about 3,500 feet of high bank shoreline. Several of the lots are developed with houses. Erosion rates along this reach are about 0.5 ft/yr, and shore protection efforts include a stone revetment. The nearshore along this reach is very deep, and typical living shoreline methods would be impractical. Downriver from Uncles Neck, at the end of Menzels Road are a few homes along the undercut and eroding low bank shoreline with a cypress tree fringe. Very little development occurs along the Chickahominy south of Menzels Road until the shoreline just upriver of the Route 5 Bridge

at the Chickahominy Riverfront Park. This shoreline has low eroding upland banks with intermittent cypress trees along shore (Figure 2-6).

The Chickahominy coast south of the Rt. 5 Bridge opens up to a southwest fetch of about 4.5 miles, and shore erosion increases up in some areas up to two feet per year. About 1,000 feet of shoreline is developed along Barret's Ferry Road. Erosion control efforts include rock revetment and bulkheads where viable alternatives would have been living shorelines in the form of sill systems.

The Governors Land development at Barrets Point occurs at the confluence of the Chickahominy and James Rivers (Reaches 1 and 2). The Governors Land coast was protected with a series of a combination of revetments, sills, spurs and breakwater systems, today what are called living shorelines (Figure 2-7). Many of these structures were installed as the high-end homes and golf course were under construction in the 1990s. Governors Land extends along the coast about 2.5 miles along the James River, Reach 2, but much of it is bordered by undeveloped swamp forest coast (Figure 2-8).

Reach 2 continues on the James River at First Colony which was first developed in the 1960s and extends downriver about 6,500 ft. This shoreline has been hardened over the years with either revetments or bulkheads (Figure 2-9) although a few scattered cypress trees still exist in the nearshore region. First Colony is bordered downriver by the Drummond Field development which began in the mid-1980s. Drummond Field is the site of the first breakwater system installed on private property in Virginia (Figure 2-10). A series of headland breakwater were installed in 1985 and have been performing as shore protection since then (Hardaway and Gunn, 2010). The 4-H Camp and Jamestown Beach Event Park also have installed breakwater systems as the preferred method of shore protection. The County Park is just upriver of the Jamestown Ferry which marks the end of Reach 2.



Figure 2-5. Reach 1 Bing map of the most upriver section of the Chickahominy in James City County.



Figure 2-6. Reach 1 undeveloped, low eroding banks on the Chickahominy River.



Figure 2-7. Reach 1 and 2 Bing map of Governors Land development at Barrets Point.

Reach 3 extends from the Jamestown Ferry Pier downriver to College Creek and includes the Colonial National Park Service's (COLO) Jamestown Island. Just downriver of the Ferry Pier coastal structures, a long jetty/breakwater at Jamestown Settlement protects three ships that are replicas of those that were first sailed into Jamestown in the 1600s. South of the Settlement, COLO's James River, Back River, Powhatan Creek, and the Thorofare shorelines were the subject of a shoreline management plan developed by the Shoreline Studies Program (Hardaway *et al.*, 1999).

Between Jamestown Settlement and the entrance to Sandy Bay, a small segment of beach extends downriver to a low revetment that protects the isthmus that connects Jamestown Island to the mainland (Figure 2-11). A short bridge over Sandy Bay connects the mainland to Jamestown Island. In early 1900s, the Jamestown site was protected by a sloped concrete block revetment which has needed repairs over the years but has provided shore protection to the site of high archeological significance. The concrete block revetment transitions to a more recently installed rock revetment that extends downriver about 1,500 feet and ties into another older revetment for another 1,500 feet. From that point, downriver to Lower Point, around Jamestown Island to Black Point and The Thorofare, a series of headland breakwaters and spurs were strategically placed in front of eroding archeological sites of national significance. The design of the structures were based on the 1999 shoreline management plan conceptual designs (Hardaway *et al.*, 1999).

Many of the headlands are placed in front of long narrow uplands which are ancient fluvial uplands which lie between adjacent marsh lands. These uplands were the only high ground that could be farmed (Figure 2-12). Farther around the southeast side of Jamestown Island, the shoreline is mostly tidal marsh coast. Here headland



Figure 2-8. Reach 2 undeveloped swamp land along the James River.



Figure 2-9. Reach 2 First Colony eroding bank behind a dilapidated bulkhead.



Figure 2-10. Reach 2 Drummond Field breakwaters that have been providing shore erosion control since 1985.



Figure 2-11. Reach 2 small revetment that protects the isthmus that connects Jamestown Island to the mainland.

control structures were placed along the shoreline to allow the adjacent shoreline to erode toward equilibrium. These structures were installed in 2003/2004. Black Point, a significant Native American site, was protected by a gapped sill and other headland breakwaters were strategically placed along the north shore of the Thorofare. Along The Thorofare and Back River, three separate sills were placed along archeological rich uplands for shore protection (Figure 2-13).

Along the north side of the Thorofare to Mill Creek, the shoreline is marsh and marsh fringe becoming low eroding upland banks as the Colonial Parkway runs adjacent to the shoreline. The shoreline consists largely of fill that was brought in to build the Colonial Parkway in the 1950s and 1960s. These low eroding sandy banks provide sand to support a long narrow beach front along much of the coast. Toward College Creek, a segment of high eroding bank has Civil War artifacts and remains unprotected. Shore erosion has provided sediments to the littoral system with the net movement downriver toward College Creek where a wide sandy beach has developed on the west side of the channel into College Creek.

Reach 4 begins at College Creek and extends downriver to Skiffes Creek (Figure 2-3). The first 2,500 feet along the James River belongs to the National Park Service (NPS) and is a high actively eroding wooded upland bank about 25 to 35 feet in height (Figure 2-14). Just downriver, the Kingsmill development begins. Kingsmill has high-end homes, golf course, and marina along the shoreline that are protected by revetments. Before the development, the eroding banks provided sandy sediments to create a beach along much of the reach. When the banks are protected and the source sand is cut off, beaches may not receive enough sand to be maintained. From the marina down to Grove Creek, the coast rises to over 70 feet high and was developed as a later phase of Kingsmill in the late 1990s and 2000s. However, a desire for a beach area to be included in the development led to the construction of a series of headland breakwaters. These were installed along the first 2,500 feet of upland coast downriver of the marina in 2000. The high banks were graded and sand fill and breakwaters were constructed to create a tertiary buffer and best management practice (BMP) that has weathered numerous storms including Hurricane Isabel in 2003. Today, the vegetated landscape includes a stable beach and backshore (Figure 2-15).

The next 2,500 feet of shoreline down to Grove Creek is still being developed. This subreach of coast was addressed in 2002 with a backshore stone revetment and three headland breakwaters, two upriver



Figure 2-12. Reach 2 Bing map showing the breakwaters that were built along Jamestown Island's James River shore.



Figure 2-13. Reach 3 marsh sill along the The Thorofare.



Figure 2-14. Reach 4 eroding high banks along the James River.

and one downriver. They were strategically placed to maintain the existing beach at each end other the revetment and graded banks. The downriver breakwater was placed to help secure the entrance to Grove Creek and has provided that function to date.

Downriver of Grove Creek, the Hampton Roads Sanitation District sewage treatment facility had a series of five short breakwaters installed over about 800 feet of once eroding upland coast. Carter's Grove Plantation occurs south of Grove Creek and extends about one mile. A few small groin fields exist along the coast, but the shoreline is mostly high eroding uplands with intermittent low fresh water swamp drainage between upland interfluves (Figure 2-16). A revetment runs along the base of the bank in front of the plantation house, but the eroding uplands could be protected by headland breakwaters.



Figure 2-15. Reach 4 breakwater, graded bank, and stable beach and backshore along the Kingsmill shoreline on the James River.



Figure 2-16. Reach 4 high eroding banks along Carters Grove Plantation.

The remaining Reach 4 shoreline along the James River extends another 2 miles to Skiffes Creek. It is mostly an actively eroding upland bank about 20 feet high with numerous fallen trees. The property is zoned industrial. Headland breakwater or headland control are appropriate strategies for this shoreline. Near the mouth of Skiffes Creek, the shoreline transitions to marsh fringe which offers wave protection to the adjacent low upland bank. Skiffes Creek is the James City County/ Newport News boundary and the location of Fort Eustis Military Reservation (on the Newport News side). Sometimes called the Army's Navy, numerous amphibious vessels are docked along the shore. Once inside Skiffes Creek, the James City County shoreline is mostly and undeveloped tidal marsh fringe coast.

Reach 5 lies along the York River side of James City County beginning at the mouth of Skimino Creek and extending upriver to Ware Creek (Figure 2-4). The reach begins as a broad tidal marsh with an erosive peat bank along the shore. The marsh extends up the York River for about one mile narrows and transitions to a low developed upland bank. The first low lot has a narrow eroding fringe that is protected by a low sill (Figure 2-17). The Riverview Plantation Drive shore extends about 4,000 feet and is an interfluve between two unnamed small tidal creeks. Most of the lots have remaining marsh fringe with an eroding peat scarp with some rock sills and revetments.



Figure 2-17. Reach 5 low marsh shoreline along the York River.

Upriver, York River State Park (YRSP) extends to just past Croaker Landing. The shoreline occurs as a series of eroding upland interfluves that reside between small tidal creeks. The uplands are generally eroding high banks with intermittent eroding fringe marsh (Figure 2-18). The undulating uplands are a product of sedimentation during higher stands of sea level, and the bank composition is a function the depositional environment. The banks generally have a clayey basal strata overlain by sandier material. The marsh fringe widens about mid-way across YRSP and provides wave protection to the upland banks which remain stable. As the marshes erode and get narrower, the base of those upland banks will become more

exposed to wave action, become undercut, and eventually become fully erosive.

Some remaining marshes act as low headlands that help hold a narrow beach and limit wave attack. Some of the bank strata is fossil bearing and provide a field experience to youth groups at the Park. The park's visitor center resides near the eroding river banks (Figure 2-19).

The shoreline becomes a wider marsh on either side of Taskinas Creek. The shoreline continues as eroding marsh fringe and, where absent, eroding upland banks up to Croaker Landing. A few homes occur on the high bank areas upriver of Croaker Landing where a change in bank height and geology occur. One area in particular has experienced significant slumping of material which is often exacerbated when trees are cleared from the top of bank (Figure 2-20). These banks are Upper Pliocene in age part of the Bacon's Castle Formation.

The shoreline transitions to a lower bank and the development called Sycamore Landing. Sycamore Landing extends about 3,500 feet along the York River coast and has homes dotting the uplands, many of which have been protected by rock revetments and graded banks. Toward the upriver end of Sycamore Landing the bank heights increase making grading more difficult. One lot has a stable base of bank with a revetment and sill and a stable lower bank face but the upper bank is still erosive (Figure 2-21). The shoreline upriver of Sycamore Landing continues as eroding upland banks with intermittent marsh fringes until the mouth of Ware Creek and associated broad marsh fringe.

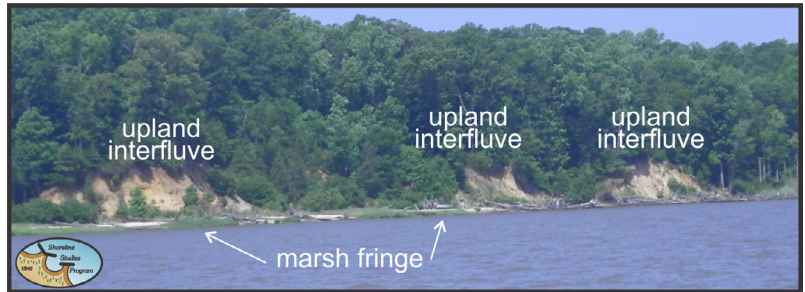


Figure 2-18. Reach 5 York River State Park eroding upland banks and marsh fringe along the shoreline.



Figure 2-19. Reach 5 eroding upland banks near the Visitor Center at York River State Park.



Figure 2-20. Reach 5 erosional slumped bank on the York River.



Figure 2-21. Reach 5 high bank with a sill and backshore revetment to stabilize the base of bank. The top of the bank is still unstable.

water levels attaining these elevations for any given year along the James River and Chickahominy River coasts. The storm surge levels are 6.4 feet MLLW, 7.8 feet MLLW, 8.5 feet MLLW and 9.8 feet MLLW, respectively. Along the York River in James City County, the storm surge levels are 5.8 feet MLLW, 7.3 feet MLLW, 8.1 feet MLLW, and 10.1 feet MLLW.

Tide ranges vary along the James City County shoreline (Table 2-2). Tide range is lowest near the mouth of the Chickahominy River and increases downriver. The mean tide range at the Chickahominy is 1.9 feet, but at Kingsmill it is 2.3 feet. Mean tide range is larger on the York River section of James City County at 2.8 feet

2.2.2 Sea-Level Rise

On monthly or annual time scales, waves dominate shore processes and, during storm events, leave the most obvious mark. However, on time scales approaching decades or more, sea level rise is the underlying and persistent force responsible for shoreline change. While trends have not been determined in James City County, the recent trend based on wave gauge data at Sewells Point on the James River shows the annual rate to be 1.5 feet/100 years (4.44 mm/yr). Boon (2012) predicted future sea-level rise by 2050 using tide gauge data from the East Coast of the U.S. Sewells Point has a projected sea-level rise of 2.03 feet (0.62 m +/- 0.22m) by 2050. The historic rate at Sewells Point (1.44 feet/100 years) will result in 0.53 feet rise in water level by 2050. This increase in sea-level warrants ongoing monitoring of shoreline condition and attention in shoreline management planning.

2.2.3 Shore Erosion

Shoreline erosion results from the combined impacts of waves, sea level rise, tidal currents and, in some cases, boat wakes and shoreline hardening. Table 2-3 shows the average historical shoreline rates of change for the reaches described in this report throughout the County. Overall, the erosion is very low in most sections of James City County. The York River shoreline is more exposed and has a greater rate of erosion than the James and Chickahominy Rivers' shorelines. Individual areas, particularly headlands or points of land have slightly larger rates of change. More detailed shoreline change information can be found in Milligan *et al.*, (2010).

Typically, when shorelines exhibit erosion, property owners have tended to harden the shoreline. Over the last 50-60 years, shoreline hardening has been the most common management solution to shoreline erosion. After years of study and review, we now understand the short and long term consequences to those choices, and there is growing concern that the natural character of the shoreline cannot be preserved in perpetuity if shoreline management does not change. While many areas in James City County on the James River have installed living shoreline breakwaters to address shore erosion control, it is important to address the unprotected, eroding shorelines.

Location	Tide Station	Mean Range (ft)	Spring Range (ft)
Kingsmill	Kingsmill	2.3	2.7
Jamestown Island	Jamestown Island	2.0	2.4
Chickahominy River	Ferry Point Bridge	1.9	2.3
Across from YRSP	Roane Point	2.8	3.4

Table 2-2. Tide Range in James City County. The first two stations are on the James River. The third is on the Chickahominy River, and the last is on the York River (from NOAA Tides and Currents Website, 2015).

Reach Name	Average EPR (ft/yr)	Category
Reach 1: Chickahominy River	-0.7	Very Low Erosion
Reach 2: James River from the mouth of Chickahominy to Jamestown Ferry	-0.7	Very Low Erosion
Reach 3: James River from Jamestown Ferry to College Creek	-0.2	Very Low Erosion
Reach 4: James River from College Creek to Skiffes Creek	-0.5	Very Low Erosion
Reach 5: York River from Skimino Creek to Ware Creek	-1.4	Low Erosion

Table 2-3. Average end point rate of change (1937-2009) for York County's shoreline. The rates of change are given in feet per year. From Milligan *et al.*, (2010).

3 Shoreline Best Management Practices

3.1 Implications of Traditional Erosion Control Treatments

Following decades of shoreline management within the constraints of Virginia’s evolving regulatory program, we have been afforded the opportunity to observe, assess, monitor and ultimately revise our understanding of how the natural system responds to perturbations associated with traditional erosion control practices. Traditional practices include construction of bulkheads, concrete seawalls, stone revetments, and the use of miscellaneous materials purposefully placed to simulate the function that revetments or bulkheads perform. These structures have been effective at stabilizing eroding shoreline; however, in some places, the cost to the environment has been significant and results in permanent loss of ecosystem function and services.

For example, bulkheads constructed close to the water correlate with sediment loss and high temperatures in the intertidal zone, resulting in impacts to organisms using those areas (Spalding and Jackson, 2001; Rice *et al.* 2004; Rice, 2006). The reduction of natural habitat may result in habitat loss if the bulkhead cannot provide substitute habitat services. The deepening of the shallow water nearshore produced by reflective wave action could reduce habitat available for submerged grass growth.

Less is known about the long-term impacts of riprap revetments. Believed to be a more ecological treatment option than bulkheads, when compared with natural systems, riprap tends to support lower diversity and abundance of organisms (Bischoff, 2002; Burke, 2006; Carroll, 2003; Seitz *et al.*, 2006). The removal of riparian vegetation as well as the intertidal footprint of riprap has led to concern over habitat loss to the coastal ecosystem (Angradi *et al.*, 2004).

3.2 Shoreline Best Management Practices – The Living Shoreline Alternative

As Virginia begins a new era in shoreline management policy, Living Shorelines move to the forefront as the preferred option for erosion control. In the guidance developed by the Center for Coastal Resources Management at the Virginia Institute of Marine Science (CCRM, 2013), Shoreline Best Management Practices (Shoreline BMPs) direct managers, planners, and property owners to select an erosion control option that minimizes impacts to ecological services while providing adequate protection to reduce erosion on a particular site. Shoreline BMPs can occur on the upland, the bank, or along the shoreline depending on the type of problem and the specific setting.

Table 3-1 defines the suite of recommended Shoreline BMPs. What defines a Living Shoreline in a practical sense is quite varied. With one exception, all of the BMPs constitute a Living Shoreline alternative. The revetment is the obvious exception. Not all erosion problems can be solved with a Living Shoreline design, and in some cases, a revetment is more practical. Most likely, a combination of these practices will be required at a given site.

Upland Shoreline BMPs	Shoreline BMPs
No Action Needed	No Action Needed
Land Use Management	Enhance/Maintain Marsh Buffer
Forest Management	Widen Marsh
Enhance/Maintain Riparian Buffer	Enhance/Maintain Beach
Grade Bank	Plant Marsh with Sill
	Beach Nourishment
	Groin Field with Beach Nourishment
	Offshore Breakwaters with Beach Nourishment
	Revetment

Table 3-1. Shoreline Best Management Practices.

3.3 Non-Structural Design Considerations

Elements to consider in planning shoreline protection include: underlying geology, historic erosion rate, wave climate, level of expected protection (which is based on storm surge and fetch), shoreline length, proximity of upland infrastructure (houses, roads, etc.), and the onsite geomorphology which gives an individual piece of property its observable character (e.g. bank height, bank slope). These parameters along with estimated cost help determine the management solution that will provide the best shore protection.

In low energy environments, Shoreline BMPs rarely require the use of hard structures. Frequently the intent of the action is to stabilize the slope, reduce the grade and minimize under cutting of the bank. In cases where an existing forest buffer is present a number of forest management practices can stabilize the bank and prevent further erosion (Figure 3-1). Enhancing the existing forest condition and erosion stabilization services by selectively removing dead, dying and severely leaning trees, pruning branches with weight bearing load over the water, planting and/or allowing for re-generation of mid-story and ground cover vegetation are all considered Living Shoreline treatment options.

Enhancement of both riparian and existing marsh buffers together can be an effective practice to stabilize the coastal slope (Figure 3-2) from the intertidal area to the upland by allowing plants to occupy suitable elevations in dynamic fashion to respond to seasonal fluctuations, shifts in precipitation or gradual storm recovery. At the upland end of the slope, forest buffer restoration and the planting of ornamental grasses, native shrubs and small trees is recommended. Enhancement of the marsh could include marsh plantings, the use of sand fill necessary to plant marsh vegetation, and/or the need for fiber logs to stabilize the bank toe and newly established marsh vegetation.

In cases where the bank is unstable, medium or high in elevation, and very steep, bank grading may be necessary to reduce the steepness of bank slopes for wave run-up and to improve growing conditions for vegetation stabilization (Figure 3-3). The ability to grade a bank may be limited by upland structures, existing defense structures, adjacent property conditions, and/or dense vegetation providing desirable ecosystem services.

Bank grading is quite site specific, dependent on many factors but usually takes place at a point above the level of protection provided by the shore protection method. This basal point may vary vertically and



Figure 3-1. One example of forest management. The edge of the bank is kept free of tree and shrub growth to reduce bank loss from tree fall.



Figure 3-2. Maintaining and enhancing the riparian and marsh buffers can maintain a stable coastal slope.

horizontally, but once determined, the bank grade should proceed at a minimum of 2:1 (2Horizontal:1Vertical). Steeper grades are possible but usually require geotechnical assistance of an expert. Newly graded slopes should be re-vegetated with different types of vegetation including trees, shrubs and grasses. In higher energy settings, toe stabilization using stone at the base of the bank also may be required.

Along the shoreline, protection becomes focused on stabilizing the toe of the bank and preventing future loss of existing beach sand or tidal marshes. Simple practices such as: avoiding the use of herbicides, discouraging mowing in the vicinity of the marsh, and removing tidal debris from the marsh surface can help maintain the marsh. Enhancing the existing marsh by adding vegetation may be enough (Figure 3-4).

In medium energy settings, additional shore protection can be achieved by increasing the marsh width which offers additional wave attenuation. This shoreline BMP usually requires sand fill to create suitable elevations for plant growth. Marshes are generally constructed on slopes between 8:1 and 14:1, but average about 10:1 (for every 10 ft in width, the elevation changes by 1 foot) (Hardaway *et al.*, 2010). Steeper systems have less encroachment into the nearshore but may not successfully stabilize the bank because the marsh may not attenuate the waves enough before they impact the bank. Shallower, wider systems have more encroachment onto nearshore bottom but also have the advantage of creating more marsh and attenuating wave energy more effectively. Determining the system's level of protection, i.e. height and width, is the encroachment.

If the existing riparian buffer or marsh does not need enhancement or cannot be improved, consider beach nourishment if additional sand placed on the beach will increase the level of protection. Beach nourishment is the placement of good quality sand along a beach shoreline to increase the beach width and raise the elevation of the nearshore area. New sand should be similar in grain size or coarser than the native beach sand. Enhancing and maintaining existing beaches preserves the protection that beaches offer to the upland as sands move naturally under wave forces and wind energy. This encourages beach and dune formation which can further be enhanced and stabilized with beach and dune plants.

Where bank and/or shoreline actions are extremely difficult or limited in effectiveness Land Use Management may be required to reduce risk. Practices and strategies may include: relocate or elevate buildings, driveway relocation, abandon or relocate sanitary drainfields, or hook-up to public sewer. All new



Figure 3-3. Bank grading reduces steepness and will improve growing conditions for vegetation stabilization.



Figure 3-4. This low-energy site had minor bank grading, sand added, and *Spartina alterniflora* planted. This photo shows the site after 24 years.

construction should be located 100 feet or more from the top of the bank. Re-directing stormwater runoff away from the top of the bank, or re-shaping the top of the bank may also assist in stabilizing the bank.

Creating a more gradual slope can involve encroaching into landward habitats (banks, riparian, upland) through grading and into nearshore habitats by converting existing sandy bottom to marsh or rock. These and other similar actions may require zoning variance requests for setbacks, and/or relief from other land use restrictions that increase erosion risk. Balancing the encroachment is necessary for overall shoreline management.

3.4 Structural Design Considerations

In medium to high energy settings, suitable “structural” Living Shoreline management strategies may be required. For James City, these are marsh sills constructed of stone and offshore breakwaters.

As fetch exposure increases beyond about 1,000 ft, the intertidal marsh width is not sufficient to attenuate wave action, and the addition of sand can increase the intertidal substrate as well as the backshore region. However, as wave exposure increases, the inclusion of some sand retaining structure may be required to prevent sand from being transported away from the site. This is where a marsh sill is appropriate.

3.4.1 Sills

The stone sill has been used extensively in the Chesapeake Bay over the years (Figure 3-5). It is a rock structure placed parallel to the shore so that a marsh can be planted behind it. The cross-section in Figure 3-5 shows the sand for the wetlands substrate on a slope approximating 10:1 from the base of the bank to the back of the sill. The elevation of the intersection of the fill at the bank and tide range will determine, in part, the dimensions of the sill system. If the nearshore depth at the location of a sill is greater than two feet, it might be too expensive for a sill relative to a revetment at that location. Nevertheless, the preferred approach would still be the marsh sill.

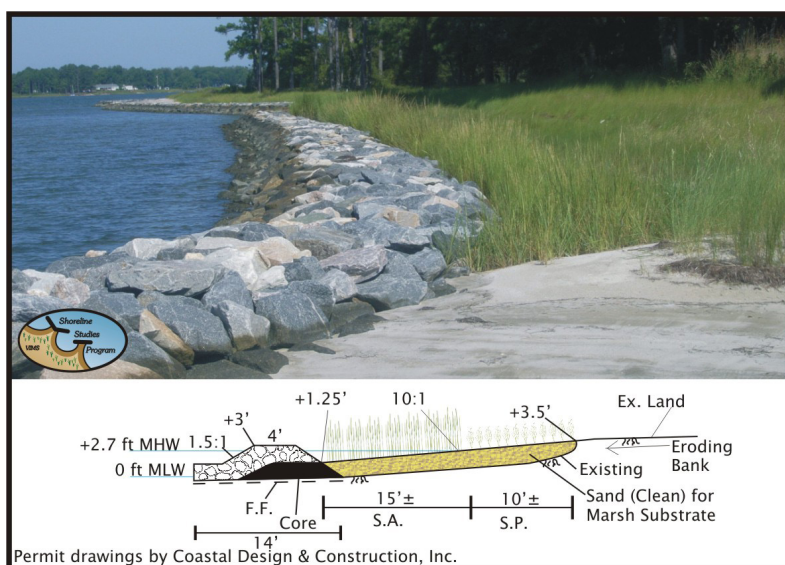


Figure 3-5. Sand fill with stone sills and marsh plantings shown six years after installation and the cross-section used for construction (From Hardaway et al., 2010).

Hardaway and Byrne (1999) indicate that in lower wave energy environments, a sill should be placed at or near MLW with sand fill extending from about mean tide level on a 10:1 to the base of an eroding bank. The height of the rock sill should be at least equal to mean high water to provide adequate backshore protection. Armor stone should be VA Class I. An installation of a sill in a low energy environment in Westmoreland County was on Glebe Creek at Hull Springs Farm (Figure 3-6). The Hull Springs Farm sill was built in 2008 along about 300 feet of shoreline. The sand fill begins at +3 feet on the bank and old bulkhead and extends on a 10:1 slope to about mid-tide (+0.8 ft mean low water) at the back of the sill. This provides planting widths of about 10 feet for *Spartina alterniflora* and 12 feet for *Spartina patens* (Hardaway et al., 2010). The sill system was built in August 2008 and went through the Veteran’s Day Northeaster (2009) with no impacts to the unprotected base of bank. Marsh fringes were heavily covered with snow and ice during the winter of 2009 but reemerged intact.

For medium energy shorelines, sills should be placed far enough offshore to provide a 40 foot wide (low bank) to 70 foot wide (high bank) marsh fringe (Hardaway and Byrne, 1999). This distance includes

the sill structure and is the width needed to attenuate wave action during seasonal storms. During extreme events when water levels exceed 3 feet above mean high water, some wave action (>2 feet) may penetrate the system. For this reason, a sill height of a least 1 foot above mean high water should be installed. Armor stone may be Class II (< 2 miles) to Class III (up to 5 miles).

Sills on high energy sites need to be very robust. Impinging wave heights can exceed 3 feet. Maintaining a vegetative fringe can be difficult. Therefore sill heights should be at least 2 feet above mean high water (MHW). The minimum size for armor stone should be Class III.

Any addition of sand or rock seaward of mean high water (MHW) requires a permit. A permit may be required landward of MHW if the shore is vegetated. As the energy environment increases, shoreline management strategies must adapt to counter existing erosion problems. While this discussion presents structural designs that typically increase in size as the energy environment increases, designs remain consistent with the Living Shoreline approach wherever possible. In all cases, the option to “do nothing” and let the landscape respond naturally remains a choice. In practice, under this scenario, the risk to private property frequently outweighs the benefit for the property owner. Along medium energy and high energy shorelines, a breakwater system can be a cost-effective alternative for shoreline protection.

3.4.2 Breakwaters

Breakwaters are a series of large rock structures placed strategically offshore to maintain stable pocket beaches between the structures. The wide beaches provide most of the protection, so beach nourishment should be included as part of the strategy and periodic beach re-nourishment may be needed.

Although single breakwaters can be used, two or more are recommended to address several hundred feet of coast. For breakwaters, the level of protection changes with the system dimensions such that larger dimensions generally correspond to bigger fetches and where a beach and dune shoreline is desired. Hardaway and Gunn (2010) and Hardaway and Gunn (2011) provide detailed research on the use of breakwaters in Chesapeake Bay.

Hardaway and Byrne (1999) suggest that breakwater systems in medium energy environments should utilize at least 200 feet of shoreline, preferably more, because individual breakwater units should have crest lengths of 60 to 150 feet with crest heights 2 to 3 feet above mean high water. Minimum mid-bay beach width should be 35-45 feet above mean high water. On high energy coasts, the mid-bay beach widths should be 45 to 65 feet especially along high bank shorelines (Figure 3-7). Crest lengths should be 90 to 200 feet. Armor stone of Class III (500 lbs.) is a minimum, but up to Type I (1500 to 4000 lbs.) may be required especially where a deep near shore exists.

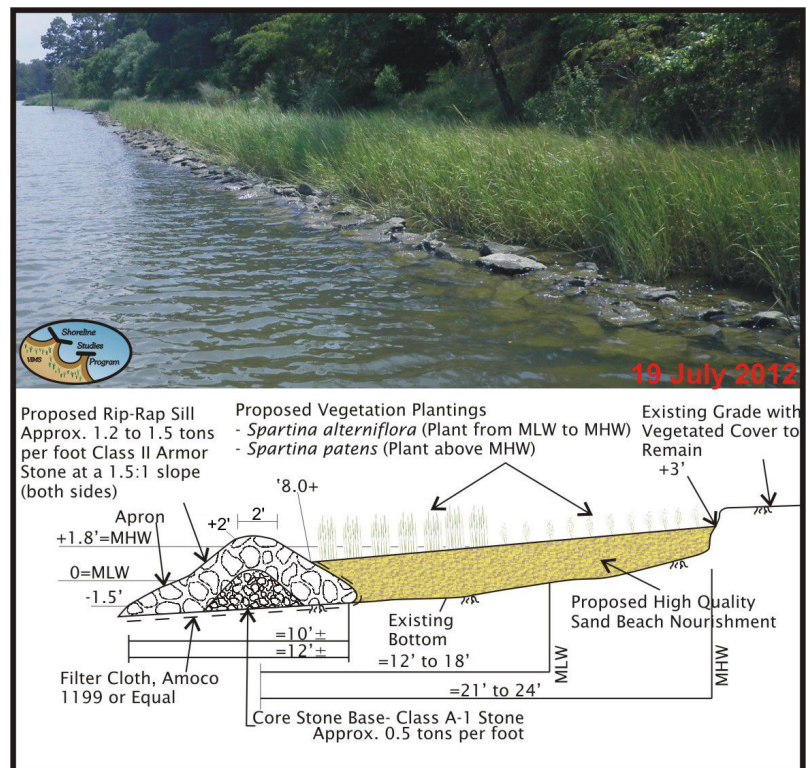


Figure 3-6. Longwood University's Hull Springs Farm four years after construction and the cross-section used for construction (from Hardaway et al., 2010).

In most cases, breakwater construction includes the addition of sand between the stone breakwater and the shore. In lower energy settings, sand may be vegetated. The backshore region should be planted in appropriate dune vegetation. In higher energy settings, the nourished sand will be re-distributed naturally under wave conditions. In some areas, additional nourishment may be required periodically in response to storms, or on some regular schedule.

3.4.3 Headland Control

Headland Control is a unique shoreline management technique whereby existing geomorphic features (i.e. headlands) are enhanced breakwaters or sills. Headland Control also can include placing stone breakwaters or sills are strategically place along eroding coasts to create headlands (Figure 2-12). These enhanced or created shore headlands are widely-spaced for economy. The adjacent coasts are allowed to continue to erode toward an equilibrium shore position or planform. The final equilibrium planform is a large pocket beach whose dimensions will depend on the amount of sand that will come to reside in the evolving embayment. Sand often is placed directly behind the created headland during construction and then vegetated. Headland control is applied to long reaches of agricultural or unmanaged woodland shores to begin the process of shore stabilization.



Figure 3-7. Breakwaters at the 4H camp designed to provide a recreational beach as well as storm erosion protection for the camp.

4 Methods

4.1 Shore Status Assessment

The shore status assessment was made from a small, shallow draft vessel, navigating at slow speeds parallel to the shoreline during field days in May and June 2015. Existing conditions and suggested strategies were entered in GIS. Once the data were compiled and evaluated, the preferred strategies were subjected to further analysis utilizing other collected data, including the condition of the bank face and toe, marsh width, landscape type, and GPS-referenced photos. The results of this analysis were compared to the results of the model described below.

4.2 Geospatial Shoreline Management Model

The Shoreline Management Model (SMM) is a geo-spatial tool that was developed to assess Shoreline Best Management Practices (Shoreline BMPs) comprehensively along tidal shoreline in Virginia. It is now necessary to provide recommended shoreline strategies that comply with an ecosystem based approach. The SMM has the capacity to assess large geographic regions quickly using available GIS data

The model is constructed using multiple decision-tree pathways that lead the user to a final recommended strategy or strategies in some cases. There are four major pathways levels. The pathways are determined based on responses to questions that determine onsite conditions. Along the upland and the bank, the model queries a site for bank stability, bank height, presence of existing infrastructure, land use, and whether the bank is defended to arrive at an upland management strategy. At the shore the model queries a site for presence and condition of beaches, marshes, the fetch, nearshore water depth, presence of specific types of erosion control structures, and creek setting to drive the shore recommendations. Appendix 1 illustrates the logic model structure.

The responses are generated by searching site specific conditional geospatial data compiled from several sources representing the most current digital data available in shapefile and geodatabase formats (Table 4-1). As indicated in Table 4-1, the majority of these data are collected and maintained

Dataset	Origin	Contribution	Variables
Shoreline Inventory	Comprehensive Coastal Inventory (CCI), Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	bank erosion	stable, erosional, defended
		riparian land use	forested
		bank height	0-30 feet, 30-60 feet, >60 feet
		beach	presence or absence
		erosion protection structures	defended; groin field present
Tidal Marsh Inventory	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	marsh width	absent, present; <15 feet wide, >15 feet wide
Roads	TIGER /Line, U.S. Census Bureau	permanent structure limiting bank grading	present or absent
Permanent Structures	created inhouse (CCI) for project, unpublished	permanent structure limiting bank grading	present or absent
Fetch	Comprehensive Coastal Inventory (CCI), Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	fetch (distance to nearest shoreline calculated in 16 directions)	low = 0-0.5 mile; moderate = 0.5 - 2 miles; high = >2 miles.
Non-Jurisdictional Beach Assessment	Shoreline Studies Program, Virginia Institute of Marine Science	wide beach (width > 10 ft)	present or absent
Bathymetry	Special Projects Office of the National Ocean Service, NOAA	nearshore water depth	shallow = 1m bathymetric contour > 10m from shoreline; deep = 1m bathymetric contour <10m from shoreline
Tributary Designation	created inhouse (CCI) for project, unpublished	tidal creek	tidal creek, major tributary, bayfront

Table 4-1. Shoreline Management Model (SMM) Data Sources and Applications.

for the James City County Shoreline Inventory. (http://ccrm.vims.edu/gis_data_maps/shoreline_inventories/virginia/jamescity/jamescity_disclaimer.htm) developed by CCRM (Angstadt *et al.*, 2014). The model is programmed in ESRI's (Environmental Systems Research Institute) ArcGIS version 9.3.1 and version 10 software.

The shoreline inventory dataset contains several attributes required for the SMM that pertain to riparian land use, bank height, bank erosion, presence of beach, existing shoreline protection structures and marshes. Other data sources provide information on nearshore depth, exposure to wave energy, marsh condition, location of beaches, and proximity of roads and permanent structures to the shoreline.

The model is built using ArcGIS Model Builder and has 13 major processing steps. Through the step-wise process specific conditions, buffers, and offsets may be delineated to accurately assess the impact that a specific condition may have on the model output. For example, a permanent structure built close to the shoreline could prevent a recommendation of bank grading as a best management practice.

To determine if bank grading is appropriate a rough estimate formula that incorporates a 3:1 slope with some padding for variability within a horizontal distance of shoreline and bank top was developed. The shoreline was buffered based on the formula:

$((3 * mh) + 20) * 0.3048$ where:

mh is the maximum height within the inventory height field (0-5 = 5ft; 5-10 = 10ft; 10-30 = 30ft; >30 = 40ft)

20 = is the padding for variability in the horizontal distance between the shoreline and the top of the bank in feet

0.3048 is the conversion from feet to meters.

Shoreline was coded for presence of permanent structures such as roads, houses, out buildings, swimming pools, etc. where observed in recent high resolution imagery to be within the computed buffer.

In the case of determining fetch or exposure to wave energy, the shoreline was divided into 50m segments, and represented by a single point on the line. Fetch distance was measured from the point to the nearest shoreline in 16 directions following the compass rose. The maximum distance over water was selected for each point to populate the model's fetch variable.

Field data from the Shoreline Inventory provided criteria to classify attributes assessed based on height (banks) or width (beaches and marshes) in many cases. Some observations were collected from other datasets and/or measured from high resolution aerial imagery. For example, the Non-Jurisdictional Beach Assessment dataset provided additional beach location data not available in the inventory. To classify beaches for the model as "wide" or "narrow", a visual inspection of imagery from the Virginia Base Map Program (VBMP), Bing, and Google Maps was used to determine where all beaches were wider than 10 feet above the high tide line.

Limitations to the model are primarily driven by available data to support the model's capacity to make automated decisions. If an existing structure is in place and the shoreline is stable, the model bases its decision on a stable shoreline. If an existing structure is in place and the shoreline is unstable, the model will return a recommendation based on the most ecological approach and will not consider the presence of the existing structure. In places where sufficient data are not available to support an automated decision, the shoreline is designated as an "Area of Special Concern". This includes shorelines that are characterized by man-made canals, marinas, or commercial or industrial land uses with bulkheads or wharfs. Marsh islands or areas designated as paved public boat ramps receive a "No Action Needed" recommendation.

The model output defines 14 unique treatment options (Table 4-2) but makes 16 different recommendations which combine options to reflect existing conditions on site and choices available

based on those conditions. The unique treatment options can be loosely categorized as Upland BMPs or Shore BMPs based on where the modification or action is expected to occur. Upland BMPs pertain to actions which typically take place on the bank or the riparian upland Shore BMPs pertain to actions which take place on the bank and at the shoreline.

Upland BMPs	Shore BMPs
Enhance Riparian Buffer	Enhance or Maintain Marsh
Forest Management	Widen marsh
Grade Bank	Plant Marsh with Sill
Land Use Management	Enhance or Maintain Beach
	Beach Nourishment
Area of Special Concern	Groin Field with Beach Nourishment
No Action Needed	Offshore Breakwaters with Beach Nourishment
	Revetment
	Area of Special Concern
	No Action Necessary

Table 4-2. Shoreline Management Model - Preferred Shoreline Best Management Practices.

5 Shoreline Management for James City County

5.1 Shoreline Management Model (SMM) Results

In the James City County, the SMM was run on 470 miles of shoreline. The SMM provides recommendations for preferred shoreline best management practices along all shoreline. At any one location, strategies for both the upland and the shore may be recommended. It is not untypical to find two options for a given site.

The majority of shoreline management in the James City County can be achieved without the use of traditional erosion control structures, and with few exceptions, very little structural control. Nearly 90% of the shoreline can be managed simply by enhancing the riparian buffer or the marsh if present. Since the much of the shoreline resides within protected waters with medium to low energy conditions, Living Shoreline approaches are applicable. Table 5-1 summarizes the model output for James City based on strategy(s) and shoreline miles. The glossary in Appendix 2 gives meaning to the various Shoreline BMPs listed in Table 5-1.

To view the model output, the Center for Coastal Resources Management has developed a Comprehensive Coastal Resource Management portal (Figure 5-1) which includes a pdf file depicting the SMM output, an interactive map viewer that illustrates the SMM output as well as the baseline data for the model (<http://ccrm.vims.edu/ccrmp/jamescity>).

The pdf file is found under the tab for Shoreline Best Management Practices. The Map Viewer is found in the CountyToolbox and uses a Google type interface developed to enhance the end-users visualization (Figure 5-2). From the map viewer the user can zoom, pan, measure and customize maps for printing. When "Shoreline Management Model BMPs" is selected from the list in the right hand panel and toggled "on" the delineation of shoreline BMPs is illustrated in the map viewing window. The clickable interface conveniently allows the user to click anywhere in the map window to receive specific information that pertains to conditions onsite and the recommended shoreline strategy. Figure 5-3 demonstrates a pop-up window displayed onscreen when a shoreline segment is clicked in the map window.

Recommended Shoreline BMPs resulting from the SMM comply with the Commonwealth of Virginia's preferred approach for erosion control.

ShoreBMP	Length (miles)
Enhance Riparian/Marsh Buffer	23.42
Enhance Riparian/Marsh Buffer OR Beach Nourishment	0.03
Enhance/Maintain Beach	0.26
Enhance/Maintain Marsh	306.22
Enhance/Maintain Riparian Buffer	15.38
Groin Field with Beach Nourishment	0.02
Maintain Beach OR Offshore Breakwaters with Beach Nourishment	19.25
Plant Marsh with Sill	18.48
Revetment	1.60
Widen Marsh	0.71
Widen Marsh/Enhance Buffer	0
Length of shore without Attributes	80.96
UplandBMPS	Length (miles)
Area of Special Concern	4.83
Enhance Riparian/Marsh Buffer	331.01
Forest Management	29.33
Grade Bank	21.49
Land Use Management	3.54
No Action Needed	76.13

Table 5-1. Occurrence of descriptive Shoreline BMPs in the James City County Watershed.

5.2 Shore Segments of Concern/ Interest

This section describes several areas of concern and/or interest in James City and demonstrates how the preferred alternative from the SMM could be adopted by the waterfront property owners. Areas of concern exist in areas where infrastructure is threatened. Areas of Interest demonstrate how the previously discussed goals of Living Shoreline management could be applied to a particular shoreline.

The conceptual designs presented in this section utilize the typical cross-sections that are shown in Appendix 3. The guidance provided in Appendix 3 describes the environments where each type of structure may be necessary and provides an estimated cost per foot. The designs presented are conceptual only; structural site plans should be created in concert with a professional experienced in the design and construction of shore protection methods in Chesapeake Bay.

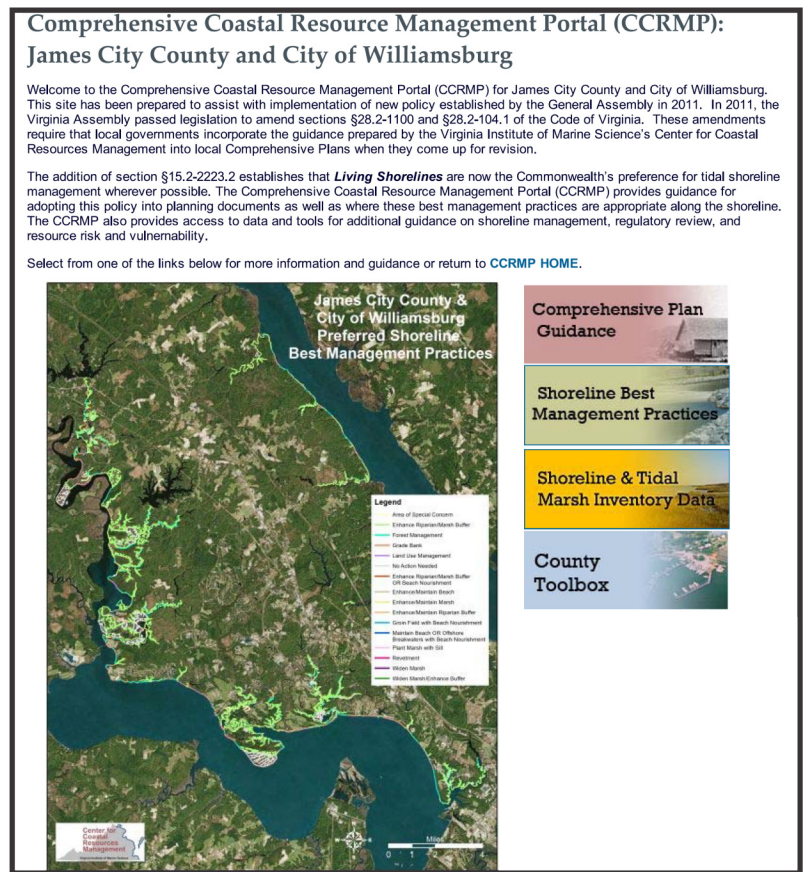


Figure 5-1. Portal for Comprehensive Coastal Resource Management in James City County.

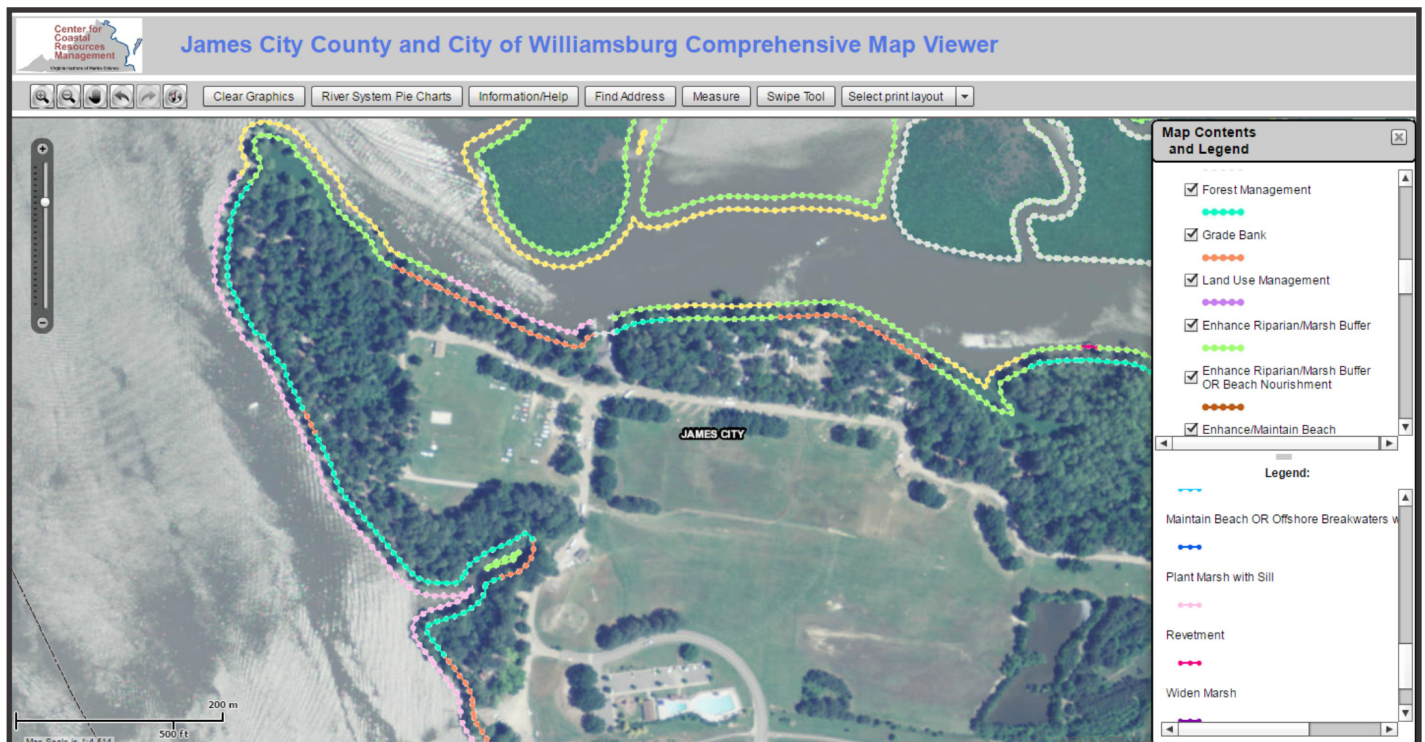


Figure 5-2. The Map Viewer displays the preferred Shoreline BMPs in the map window. The color-coded legend in the panel on the right identifies the treatment option recommended.

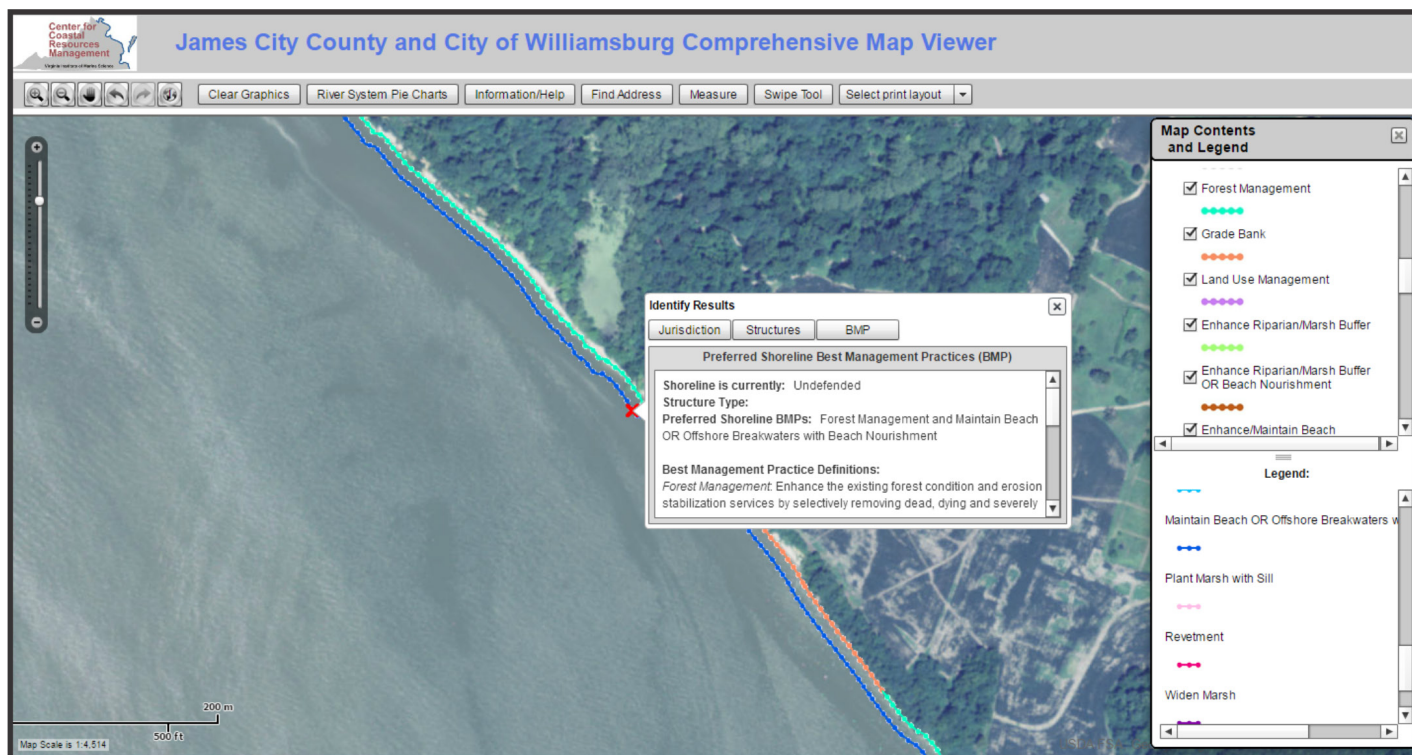


Figure 5-3. The pop-up window contains information about the recommended Shoreline BMP at the site selected. Additional information about the condition of the shoreline also is given.

5.2.1 Chickahominy River Park (Area of Concern)

Chickahominy Riverfront Park is on the Chickahominy River at the Rt. 5 Bridge (Figure 2-2). It faces southwest with fetch exposures to the south of five miles and to the northwest of one and a half miles. Though the long-term erosion rate (1937-2009) is low along the riverfront shore reach (Milligan *et al.*, 2010), the low bank is scarped and eroding. Several camping sites exist along this stretch of shore and could potentially be impacted (Figure 2-6).

The SMM recommends a BMP of a marsh with sill along this shoreline. A conceptual design of a shore protection system which would manage the shoreline includes eight sills along about 1,600 feet of shoreline (Figure 5-4). The gapped sills would allow fauna to utilize the marshes and provides access for recreation. The cross-section for a typical sill for this site is shown in Appendix 3, Figure 1.



Figure 5-4. Proposed configuration of Shoreline BMP at Chickahominy Riverfront Park.

5.2.2 Colonial Parkway (Area of Interest)

The Colonial Parkway is a 23 mile scenic roadway that transits mostly along the shoreline of the York and James Rivers. The Parkway was completed in 1957 and is managed by the National Park Service. Sections of the road along the Thorofare to College Creek (Figure 2-3) was constructed using fill material that was placed along the shore. A section of the shoreline east of Mill Creek has eroded and is close to the road (Figure 5-5). The road in this area was built on material that was placed at the entrance to Glebe Gut. In 1937, the Glebe was a creek that exited to the James River (Milligan *et al.*, 2010). The fill material was likely placed on sediment that was softer than the surrounding material. Over time, the coast in the

area of interest has eroded more than the headlands on either side.

The SMM recommends a sill with marsh along sections of this shoreline. A conceptual design includes four sill structures strategically placed along the existing headlands (Figure 5-6). These structures are designed for the medium to high wave climate that can reach this stretch of shoreline. They will reduce the erosion so that the road is not threatened in the future as well as provide recreational access. The cross-section for a typical sill for this site is shown in Appendix 3, Figure 2.

5.2.3 York River State Park (Area of Interest)

The shoreline along the York River State Park on the York River has a long-term (1937-2009) erosion rate up to -2.5 feet per year in some areas. The high banks are eroding leaving fallen trees and scarped banks along the shoreline (Figure 5-7). This is a high energy area that has a fetch to the northwest of 7.5 miles and southeast of 15.5 miles.

The SMM recommends offshore breakwaters which will provide shore protection and recreational access to the shoreline. Conceptual designs are provided for two separate areas along the York River State Park shoreline (Figure 5-8). These are in line with earlier designs created by the U.S. Army Corps of Engineers. In the first area near the Visitor's Center, four offshore breakwaters and two transitional sills are recommended which will provide beach and marsh habitat, respectively. The structures farther downriver are in front of high eroding banks. These three offshore breakwaters will stabilize the base of bank from severe storm attack. Bank grading is optional. The cross-section for a typical sill for this site is shown in Appendix 3, Figure 3.

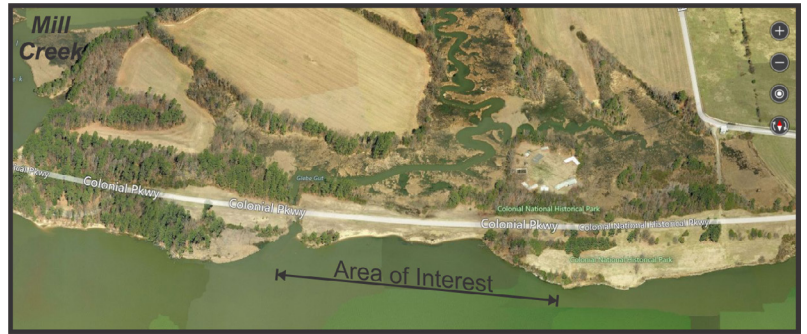


Figure 5-5. Existing conditions at the site of the Colonial Parkway area of interest.

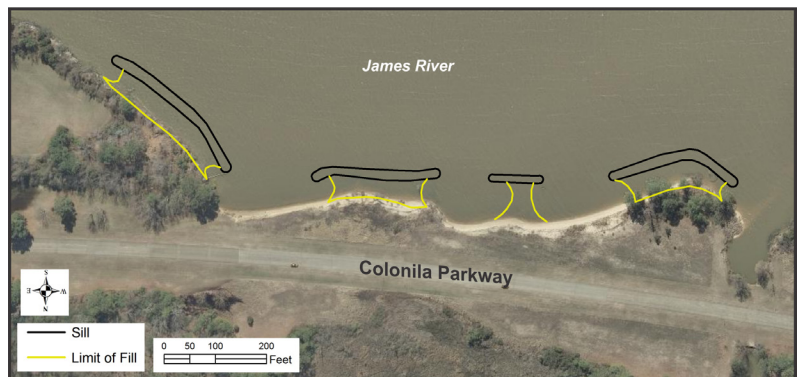


Figure 5-6. Proposed configuration of the sill shoreline BMP for Colonial Parkway.



Figure 5-7. Existing conditions at the site of the York River State Park area of interest.

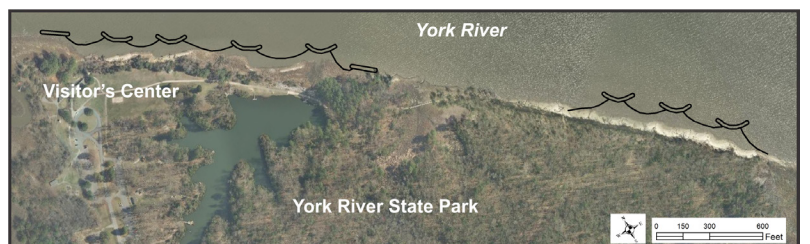


Figure 5-8. Proposed configuration of Shoreline BMP for York River State Park.

6 *Summary and Links to Additional Resources*

The Shoreline Management Plan for James City County is presented as guidance to County planners, wetland board members, marine contractors, and private property owners. The plan has addressed all tidal shoreline in the locality and offered a strategy for management based on the output of a decision support tool known as the Shoreline Management Model. The plan also provides some site specific solutions to several areas of concern that were noted during the field review and data collection in the county. In all cases, the plan seeks to maximize the use of Living Shorelines as a method for shoreline stabilization where appropriate. This approach is intended to offer property owners with alternatives that can reduce erosion on site, minimize cost, in some cases ease the permitting process, and allow coastal systems to evolve naturally.

Additional Resources

VIMS: James City County Map Viewer

http://cmap.vims.edu/CCRMP/JamesCityCCRMP/JCC_Wmsbg_CCRMP.html

VIMS: Living Shoreline Design Guidelines

http://www.vims.edu/research/departments/physical/programs/ssp/_docs/living_shorelines_guidelines.pdf

VIMS: Why a Living Shoreline?

<http://ccrm.vims.edu/livingshorelines/index.html>

VIMS: Shoreline Evolution for James City County

http://web.vims.edu/physical/research/shoreline/docs/Cascade/Shoreline_Evolution/JamesCityShoreEvolve-lr.pdf

NOAA: Living Shoreline Implementation Techniques

<http://www.habitat.noaa.gov/restoration/techniques/livingshorelines.html>

Chesapeake Bay Foundation: Living Shoreline for the Chesapeake Bay Watershed

<http://www.cbf.org/document.doc?id=60>

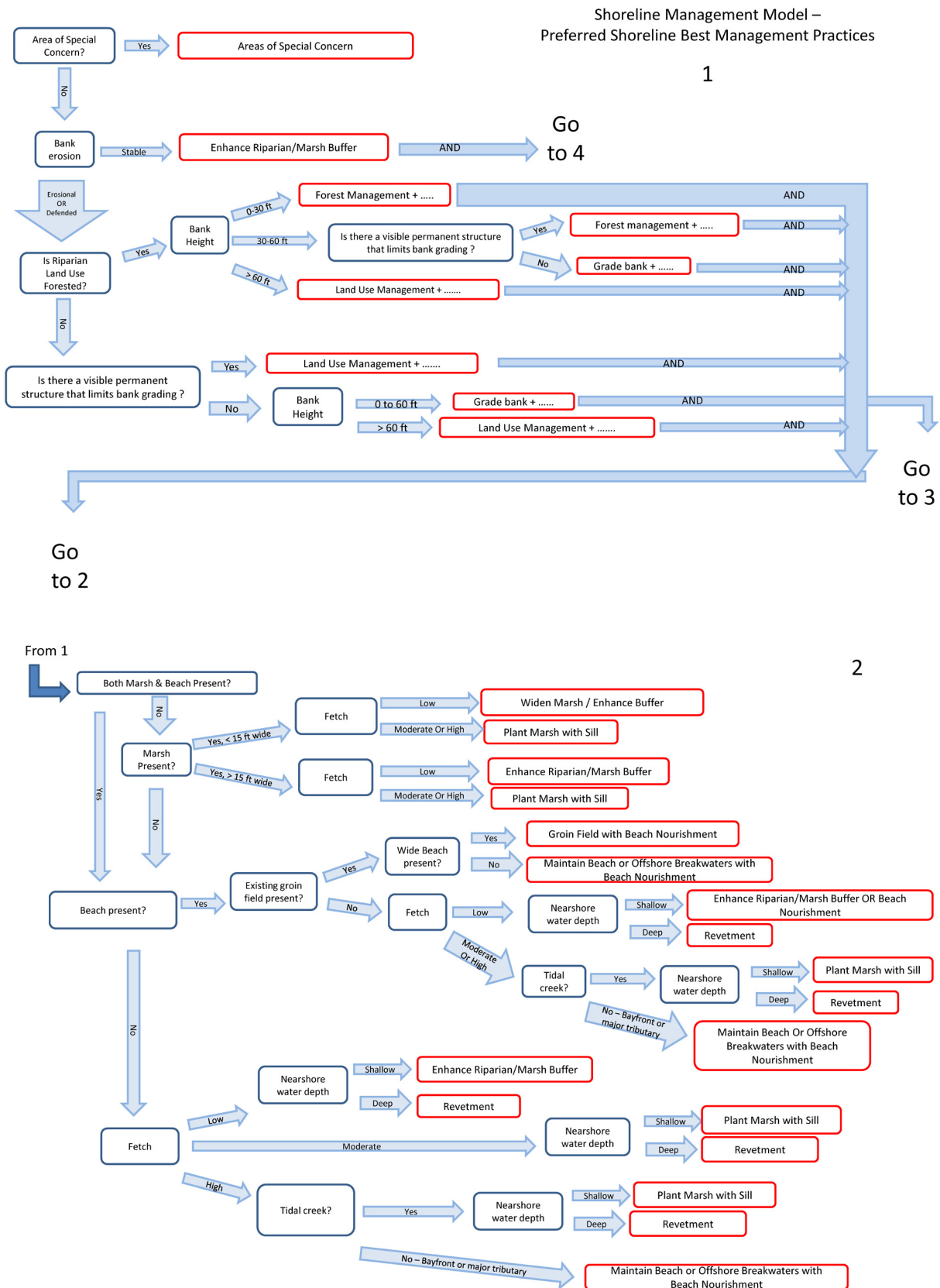
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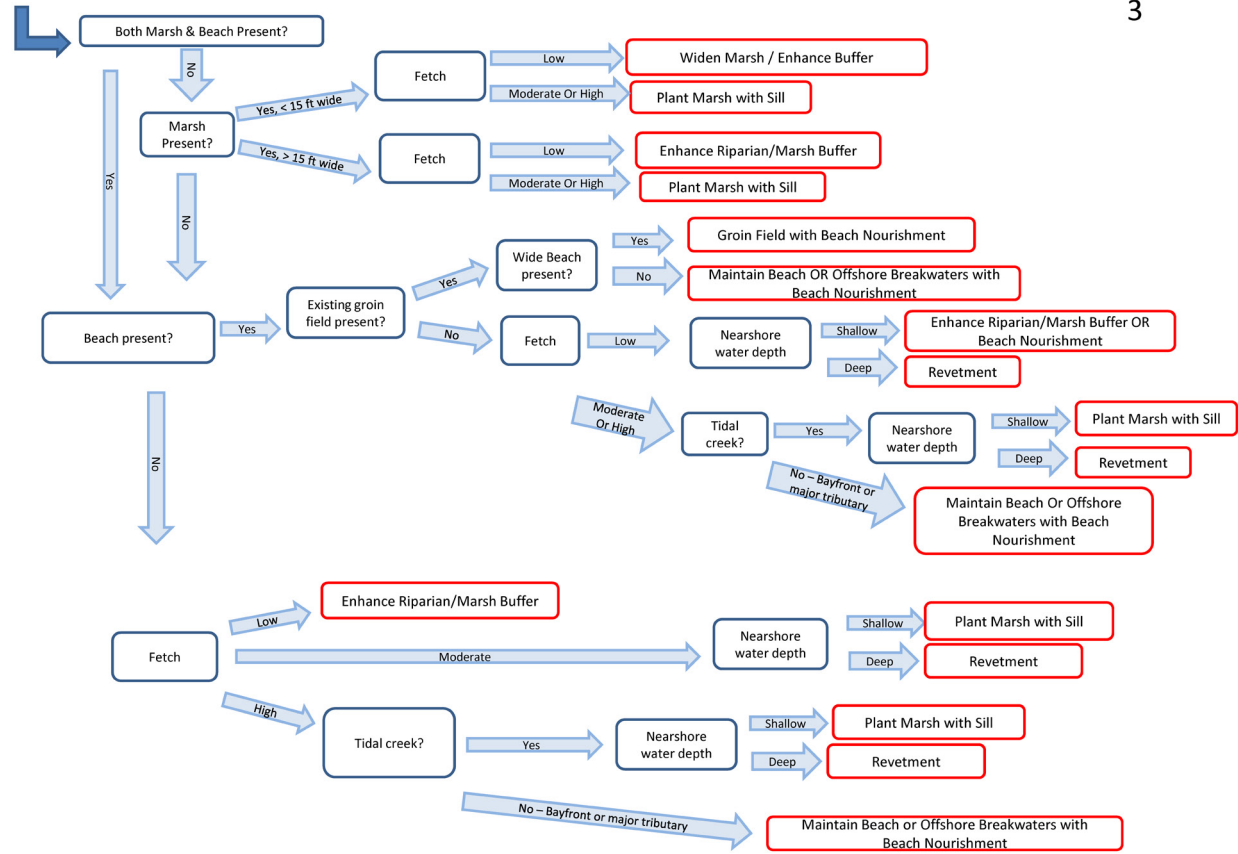
APPENDIX 1

Shoreline Management Model Flow Diagram



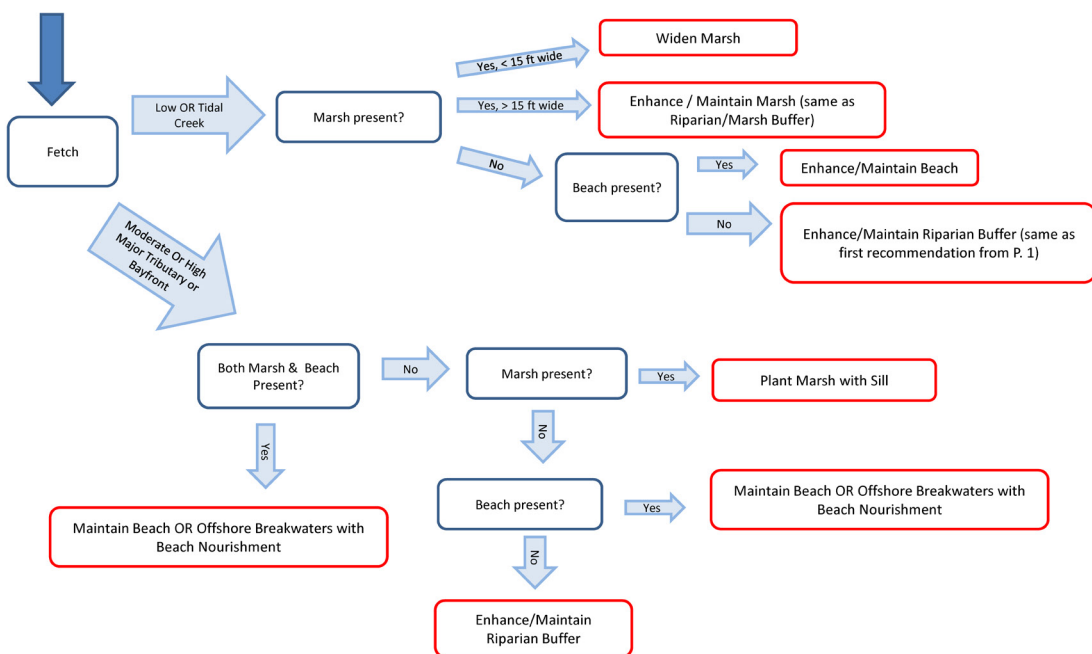
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APPENDIX 2

Glossary of Shoreline Best Management Practices

Preferred Shoreline Best Management Practices

Areas of Special Concern (Marinas - Canals - Industrial or Commercial with bulkhead or wharf – Other Unique Local Features, e.g. developed marsh & barrier islands) - The preferred shoreline best management practices within Areas of Special Concern will depend on the need for and limitations posed by navigation access or unique developed areas. Vegetation buffers should be included where possible. Revetments are preferred where erosion protection is necessary. Bulkheads should be limited to restricted navigation areas. Bulkhead replacement should be in same alignment or landward from original bulkhead.

No Action Needed – No specific actions are suitable for shoreline protection, e.g. boat ramps, undeveloped marsh & barrier islands.

Upland & Bank Areas

Land Use Management - Reduce risk by modifying upland uses, apply where bank and/or shoreline actions are extremely difficult or limited in effectiveness. May include relocating or elevating buildings, driveway relocation, utility relocation, hook up to public sewer/abandon or relocate sanitary drainfields. All new construction should be located 100 feet or more from the top of the bank. Re-direct stormwater runoff away from top of the bank, re-shape or grade along top of the bank only. May also include zoning variance requests for setbacks, relief from other land use restrictions that increase erosion risk.

Forest Management - Enhance the existing forest condition and erosion stabilization services by selectively removing dead, dying and severely leaning trees, pruning branches with weight bearing load over the water, planting or allow for re-generation of mid-story and ground cover vegetation, control invasive upland species introduced by previous clearing.

Enhance/Maintain Riparian Buffer – Preserve existing vegetation located 100 ft or less from top of bank (minimum); selectively remove and prune dead, dying, and severely leaning trees; allow for natural re-generation of small native trees and shrubs.

Enhance Riparian/Marsh Buffer – Vegetation stabilization provided by a blended area of upland riparian and/or tidal marsh vegetation; target area extends from mid-tide to upland area where plants can occupy suitable elevations in dynamic fashion, e.g. seasonal fluctuations, gradual storm recovery; no action may be necessary in some situations; may include existing marsh management; may include planted marsh, sand fill, and/or fiber logs; restore riparian forest buffer where it does not exist; replace waterfront lawns with ornamental grasses, native shrubs and small trees; may include invasive species removal to promote native vegetation growth

Grade Bank - Reduce the steepness of bank slope for wave run-up and to improve growing conditions for vegetation stabilization. Restore riparian-wetland buffer with deep-rooted grasses, perennials, shrubs and small trees, may also include planted tidal marsh. NOTE - The feasibility to grade bank may be limited by upland structures, existing defense structures, adjacent property conditions, and/or dense vegetation providing desirable ecosystem services.

Tidal Wetland – Beach – Shoreline Areas

Enhance/Maintain Marsh – Preserve existing tidal marsh for wave attenuation. Avoid using herbicides near marsh. Encourage both low and high marsh areas, do not mow within 100 ft from top of bank. Remove tidal debris at least annually. Repair storm damaged marsh areas with new planting.

Widen Marsh – Increase width of existing tidal marsh for additional wave attenuation; landward design preferred for sea level rise adjustments; channelward design usually requires sand fill to create suitable elevations.

Widen Marsh/Enhance Buffer – Blended riparian and/or tidal marsh vegetation that includes planted marsh to expand width of existing marsh or create new marsh; may include bank grading, sand fill, and/or fiber logs; replace waterfront lawns with ornamental grasses, native shrubs and small trees.

Plant Marsh with Sill – Existing or planted tidal marsh supported by a low revetment placed offshore from the marsh. The site-specific suitability for stone sill must be determined, including bottom hardness, navigation conflicts, construction access limitations, orientation and available sunlight for marsh plants. If existing marsh is greater than 15 ft wide, consider placing sill just offshore from marsh edge. If existing marsh is less than 15 ft wide or absent, consider bank grading and/or sand fill to increase marsh width and/or elevation.

Enhance/Maintain Beach - Preserve existing wide sand beach if present, allow for dynamic sand movement for protection; tolerate wind-blown sand deposits and dune formation; encourage and plant dune vegetation.

Beach Nourishment - Placement of good quality sand along a beach shoreline to increase the beach width and raise the elevation of the nearshore area; grain size of new sand should be similar to native beach sand

Enhance Riparian/Marsh Buffer OR Beach Nourishment – Increase vegetation stabilization with a blended area of upland riparian and/or tidal marsh vegetation; restore riparian forest buffer where it does not exist; replace waterfront lawns with ornamental grasses, native shrubs and small trees; may include planted marsh, sand fill, and/or fiber logs.

Consider beach nourishment if existing riparian/marsh buffer does not need enhancement or cannot be improved and if additional sand placed on the beach will increase level of protection. Beach nourishment is the placement of good quality sand along a beach shoreline to increase the beach width and raise the elevation of the nearshore area; grain size of new sand should be similar to native beach sand.

Maintain Beach OR Offshore Breakwaters with Beach Nourishment – Preserve existing wide sand beach if present, allow for dynamic sand movement for protection; nourish the beach by placing good quality sand along the beach shoreline that is similar to the native sand.

Use offshore breakwaters with beach nourishment only where additional protection is necessary. These are a series of large rock structures placed strategically offshore to maintain stable pocket beaches between the structures. The wide beaches provide most of the protection, so beach nourishment should be included; periodic beach re-nourishment may be needed. The site-specific suitability for offshore breakwaters with beach nourishment must be determined, seek expert advice.

Groin Field with Beach Nourishment - A series of several groins built parallel to each other along a beach shoreline; established groin fields with wide beaches can be maintained with periodic beach nourishment; repair and replace individual groins as needed.

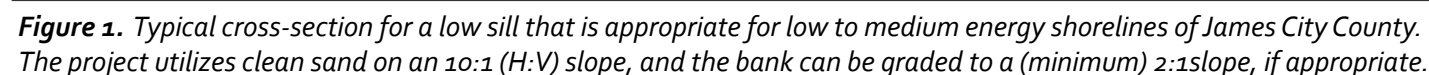
Revetment - A sloped structure constructed with stone or other material (riprap) placed against the upland bank for erosion protection. The size of a revetment should be dictated by the wave height expected to strike the shoreline. The site-specific suitability for a revetment must be determined, including bank condition, tidal marsh presence, and construction access limitations.

Guidance for Structural Design and Construction in James City County

Stone sills are effective management strategies in all fetch exposures where there is shoreline erosion; however, in very low energy environments the non-structural shoreline best management practices described in Chapter 3 of this report may provide adequate protection, be less costly, and more ecological beneficial to the environment. Stone revetments in low energy areas, such as creeks, are usually a single layer of armor. In low, medium, and high wave energy shores, the structure should become a more engineered coastal structure. In the lower fetch areas of James Bay, stone sills are not recommended. Along medium energy shorelines or where there is no shoreline erosion, stone sills are not recommended (Appendix 3, Figure 2). Using sills on the open coast is not recommended due to the severity of storm wave attack.

Table 1. Approximate typical structure cost per linear foot.

structure. In the lower fetch areas of James City, a low sill might be appropriate (Appendix 3, Figure 1). Along medium energy shorelines or where there is nearby upland infrastructure, a high sill would be better (Appendix 3, Figure 2). Using sills on the open river requires careful consideration and design due to the severity of storm wave attack.



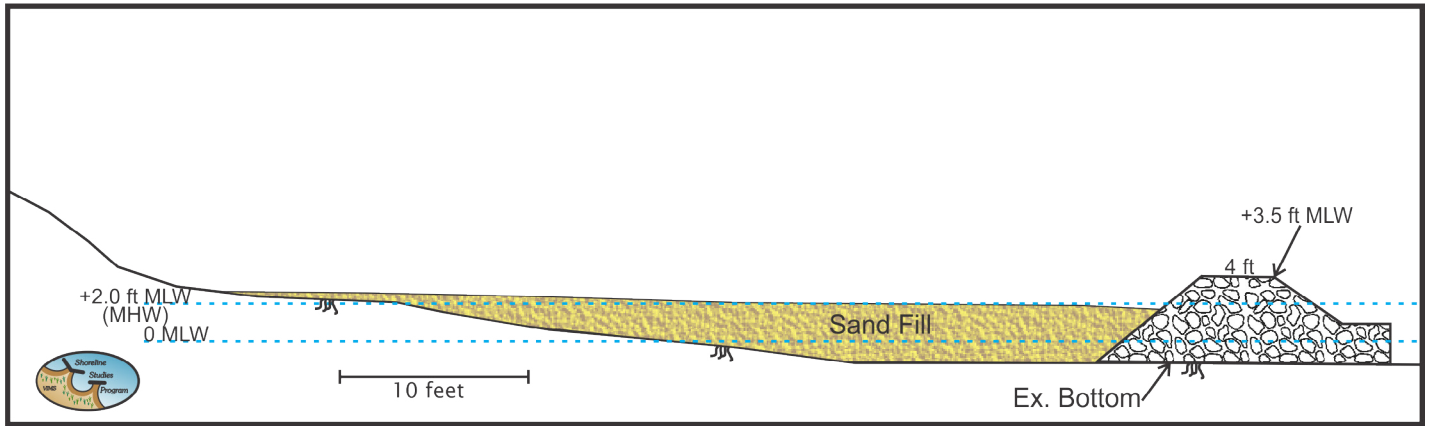


Figure 2. Typical cross-section for a large sill that is appropriate for the medium to high energy shorelines of James City County. The project utilizes clean sand, and the bank can be graded to a (minimum) 2:1 slope, if appropriate.

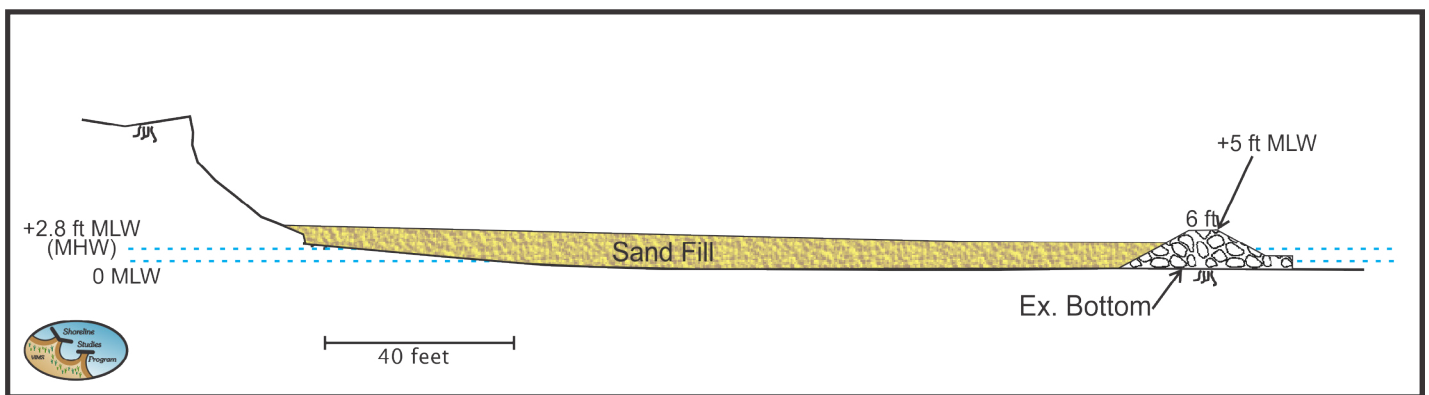


Figure 3. Typical cross-section for a breakwater that is appropriate for shore protection along the medium to high energy shorelines of James City County. The project utilizes clean sand, and the bank can be graded to a (minimum) 2:1 slope, if appropriate.

